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ABSTRACT

In this study, 50 infants (15 to 18 months of age) were shown four different film sets in an effort to determine (1) whether infants can perceive action role reversals between an actor and recipient of the action when the direction of the action is ruled out as a cue and (2) whether infants consider only animate objects to be potential action-agents. These questions were based on the assumption that language acquisition is based on a cognitive non-linguistic foundation of concepts, categories and meanings. Films were made depicting first standard, then reversal, events. The standard events consisted of repeated trials of actor A (a male actor) pushing actor B (either another male actor or a chair), with position and direction alternating. In the role reversal events, actor B pushed actor A, again with position and direction varying. Visual fixation and heart rate were measured while infants viewed the films. Data from 26 of the subjects were used, since data from the other subjects were unusable due to fretting, excessive moving or equipment failure. Results indicated that action role reversals are perceived by infants regardless of changes in the direction of action; there was little evidence that infants consider the category of agent to include only animate objects. The implication of the findings in relation to language learning is discussed. (SB)

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INFANTS' PERCEPTION OF SEMANTICALLY DEFINED ACTION ROLE CHANGES IN FILMED EVENTS

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Brown (1973), Lenneberg (1967), Ervin-Tripp (1973), Macnamara (1972), Wells (1974), Edwards (1974) and others have assumed that the acquisition of language is based on a cognitive nonlinguistic base rich with concepts, categories, and meanings. The cognitive relations constructed by the infant from his sensori-motor interactions in the world are translated into language and appear as semantic relations in his earliest multi-word, and perhaps even single word, utterances (Bloom, 1970; Brown, 1973; Schlesinger, 1971; Greenfield, Smith & Laufer, in press). Schlesinger (1974) has written that there "seems to be no evidence for the psychological reality of any classification of those [cognitive] relations". However, some evidence for the psychological reality of one set of these relations does exist. Preliminary attempts to operationalize the categories of "agent" and "recipient" have provided support for infants' discriminations of these relations in perceptual events (Golinkoff, 1975; McHale, 1973; Gilmore, Suci & Chan, 1974).

An actor is described as the "agent" when he initiates the action and is "recipient" when he receives it. This distinction is fundamental in recent linguistic accounts of the semantic units that underlie language processing (Chafe, 1971; Fillmore, 1968). Suci (1971) has termed the agent/recipient dichotomy action role and his research (Suci & Hamacher, 1972) as well as others, has indicated that the action role distinction is a psychologically significant aspect of sentence processing. Furthermore, as assessed in psycholinguistic judgment tasks, adults and children prefer animate agents (viz., people and animals) over inanimate agents or instrumentals (viz., trucks and hammers) (Clark & Begun, 1971; Howe & Hillman, 1973). The primary purpose of the present study was to examine infants' perceptions of the agent-

recipient relationship in filmed events and to determine whether infants know that only animate objects may be agents.

To study the global distinction between action initiation and action recipience, McHale (1973) used puppets to assess whether infants were more sensitive to events where actors reversed roles (a hits b then b hits a) than to a control event where the agent-recipient relationship was not altered. She found that children who were more linguistically mature than their peers watched the action role reversal more than the control event. While these results may indicate that infants discriminated action initiation from action recipience, they may indicate only that infants attend to the moving object since the recipient did not move in McHale's film.

Golinkoff (1975) confirmed McHale's findings with actors who moved in both the agent and recipient roles. Visual fixation was monitored as infants watched two types of action role reversals and one type of control event. In the repetitive standard event, the infants were shown six successive presentations of a man pushing a woman from left to right across the screen (M→W). Two kinds of action role reversals were created: In one the direction of the action remained constant but the position as well as the roles of the actors changed (W →M). In the other, the position of the actors remained the same, but the direction of action changed with the action role reversal (M←W). The 14-24 month old subjects watched the action role reversal with the direction change significantly more than the control event which changed only position of the actors and direction of the action (W←M). Unexpectedly, however, the action role reversal with the position change was apparently not discriminated from the control event.

These results suggested that while infants could distinguish between agents and recipients in perceptual events, the direction of the action influenced the perception of action role reversals.

Moreover, with cardiac deceleration as the dependent variable, a related finding was obtained by Gilmore et al. (1974), using one of the Golinkoff (1975) films. While both types of action role reversals seemed to have been detected, the action role reversal with the direction change received greater heart rate deceleration than the action role reversal with the position change. The present study was designed to rule out direction as a cue for action role reversals by having both the repeated standard events and the subsequent action role reversals contain changes in direction.

This study was also designed to assess whether infants consider inanimate objects made to perform as agents to be a violation of the category of agent. Since animacy seems to be an important feature of the concept of agent (less so for the concept of recipient) "agent" has been defined as the animate instigator of a transitive action while "recipient" is defined as the animate or inanimate object of the action. Brown (1973) has noted that the animacy feature presents an interesting paradox in early child speech. As compared to the grammar that describes the adult language, children observe the animate-inanimate restriction where it is not required (e.g., by making their "sentence" subjects overwhelmingly animate) and ignore it where it is required (e.g., when they say things such as "hi spoon"). Without independent cognitive evidence it is not possible to conclude whether infants make the animate-inanimate distinction but fail to mark it reliably in their speech. Perhaps Piagetian sensori-motor Stage 5 of infancy is the time when "the

infant...especially differentiates objects which can be a cause for an action and/or act from those which can not" (Moerk, 1975, p. 163). Objects may become meaningful by virtue of their interrelations with other objects (including the knowing organism) and may be "understood relative to their roles in events" (Bransford & McCarrell, 1974, p. 197). The knowledge that only animate things cause actions and use other objects instrumentally may be abstracted during the prelinguistic period even though this distinction is only inconsistently marked in early language. The alternative hypothesis would be, of course, that infants consider all objects to be potential agents.

A prior attempt to answer this question (Golinkoff, 1975) was inconclusive, perhaps due to a methodological problem in that study. In the present study, infants' responses to anomalous action role reversals in a film with a man and a chair were compared to their responses to plausible action role reversals between two men. If infants are sensitive to the animacy restriction, it was predicted that anomalous action role reversals would be responded to significantly more than plausible action role reversals.

A greater response to anomaly and to action role reversals relative to repeated standard events was predicted based on the magnitude of discrepancy hypothesis employed in infant habituation research (e.g., McCall, 1971). Golinkoff (1975) can be consulted for justification of this paradigm's extension for use with filmed events. Golinkoff (1975) and McHale (1973) found visual fixation responses to be reliable measures of habituation to filmed events. Cardiac deceleration reliably indexed attentional changes within and between complex events in Gilmore, et al.'s (1974) experiment. The present study attempted to replicate the finding that cardiac deceleration, in addition to visual fixation, can be used to assess discrimination of

complex filmed events.

In summary, this study was designed to extend the findings of prior studies by determining whether infants could perceive action role reversals when the direction of action is ruled out as a cue. Second, it was also designed to uncover whether infants consider only animate objects to be potential agents. The final concern was whether these discriminations could be reflected in the heart rate response.

Method

The Stimulus Events

Four films were constructed, two of which had two male actors, and the other two used a man and a chair. One film of each type consisted of six standard events followed by six reversal events (12-event films), while the other set had eight standard and eight reversal events (16-event films). The standard consisted of repeated trials of actor A pushing actor B (see Figure 1). Position and direction alternated in each subsequent event. The action role reversal events (actor B pushing actor A) continued to vary position and direction, although in the first reversal trial the position of the actors did not change. The direction of action feature that past studies have found to influence the perception of action role reversals continued to change. There was no temporal or physical break between the end of the standard and the start of the reversal events.

The live male actors in the man-man film (one dressed in green and the other in red), or the brown wooden chair and the male actor dressed in lavender in the man-chair film, faced each other with no movement. The agent took two steps forward (the chair was pulled from off camera by unseen strings tied to its forward legs) and pushed the recipient. Human agents

Insert Figure 1 about here

walked with their hands slightly lifted, palms down, pushed the recipient on the abdomen and then stopped. The recipient then took two steps backwards with their hands slightly raised (as though from impact). When the chair was agent, it "pushed" the man by making contact with his slightly outstretched hands. When the chair was recipient the man used his slightly outstretched hands to push it.

Each event was filmed against a beige backdrop and covered the same distance. Identical events within each type were created by film duplication. Since each event was 6-seconds long and 1 1/2-seconds of black film separated events, the 12-event films were approximately 90 seconds long and the 16-event films were close to 120-seconds long.

Subjects and Apparatus

Fifty full-term, normal, male and female infants between the ages of 15 and 18 months ($\bar{X}$ = 16;5) were each shown one of the films. The parent's consent was obtained in telephone contacts and again immediately prior to the experiment when the parent was informed of the details of the procedure.

A Super 8mm movie projector showed the silent color films on a rear projection screen where the image was 13" x 9". The infant's visual fixation was assessed by a seated observer hidden from view, who pressed a switch when light from the film was reflected in the subject's pupil. Inter-observer reliability in this procedure is typically above r = .95. The output of this switch was recorded on a Grass Model 7 polygraph, along with the output of a photocell placed at the edge of the projection screen. The photocell was used to indicate the beginning and end of each event on the film. The infant's heart rate was obtained by attaching three Beckman miniature

electrodes to the infant's chest and back with adhesive collars and amplifying the output with a Grass preamplifier. The EKG and heart rate were recorded on the polygraph, and a special purpose computer interface calculated the time between consecutive R-waves in the EKG. All of the interbeat or R-R intervals were stored in a PDP-8 computer and printed out at the end of the test session.

Procedure

After an initial period of adaptation to the environment the subject's receptive vocabulary was assessed in an informal way by asking the child to give the experimenter or his mother various toy items scattered in front of him. The 15 common nouns which were tested were taken from Nelson (1973). Children's comprehension of four verbs was also assessed by asking them to perform each action on an object. Throughout the session all of the subject's spontaneous utterances were either recorded on tape or written down by an observer.

Following the receptive vocabulary test, the parent placed S in the high chair. Another experimenter entered the room, placed the three electrodes on the child with the parent's assistance, and then left. The mother was urged not to distract the child in any way once the film came on. The infant was then given a large hard pretzel stick and the film started. The parent, who sat to the child's right and the experimenter, who sat to the child's left, both watched the film.

Results

The experiment began using the longer 16-event films and it was found that with 8 repetitions of the standard event, many subjects' cardiac data was unusable due to fretting and excessive movement before the action

role reversals appeared. As a result, the films were shortened to 6 standard and 6 reversal events. While the visual fixation data from all subjects were used, none of the 16-event heart rate data and 76% (n = 26) of the 12-event heart rate data were used. Heart rate data for eight subjects were eliminated because of excessive movement, fretting, or equipment failure.

Visual Fixation Data

A preliminary analysis revealed no effect of sex at the point of the action role reversal and that variable was pooled in subsequent analyses. The total visual fixation time for each trial of the standard events (6 or 8 trials) and for the first two action role reversals was computed for each subject. For each of the four films (i.e., the man-man and man-chair films with 12 and 16 events), a second-degree polynomial equation based on the means for the standard events was then computed. This equation was used to predict how much visual fixation the first and second action role reversals would receive if the generally downward habituation trend continued. If infants discriminated the reversal events from the standards, however, visual fixation on the first two reversals should be significantly higher than the predicted values. This analysis is similar to one used previously by Lewis and Goldberg (1969).

Figure 2 presents the mean visual fixation time on each trial of the standard and the first two reversals in both 12-event films. On the action role reversals the predicted means (dotted line) for each film were tested against the observed means. These tests indicated that the first two reversals in the man-chair film were both watched significantly more than the

Insert Figure 2 about here

predicted amount, $p < .01$[1]. Neither of the first two reversals in the man-man film was watched more than the predicted amount, $p > .05$.

Figure 3 presents the mean visual fixation time per trial in the 16-event films. The first and second reversals in both films were watched significantly more than the predicted amount, $p < .05$ and .01 for the first and second reversals in the man-chair film respectively, and $p < .05$ for the first and second reversals in the man-man film. In sum, visual fixation data from three out of the four films indicated that the action role reversals had been perceived.

Insert Figure 3 about here

Cardiac Responses

A preliminary analysis revealed no effect of sex at the appearance of the reversal and that variable was pooled in subsequent analyses. To evaluate whether the cardiac data indicated perception of the reversal, subjects' responses on three of the events were compared: the first or second standard, the next to the last or last standard, and the first or second reversal. The selection of a member from each of these 3 pairs was made on the basis of where the most visual fixation occurred for each subject. When visual fixation in any of these pairs was identical, the first standard, last standard, and first reversal were chosen. Each of these events was divided into 12 half-second intervals starting at the onset of the event. The average heart rate for the 1 1/2 seconds of black film prior to the event was used as a base rate for the event which followed and the heart rate for each half-second during the event was subtracted from this base

[1]Tests of significance for the observed values were based on the confidence limits for the predicted points.

rate. Thus, the infant's cardiac response to each event was compared to a baseline immediately prior to the event. Although the subjects did not always fixate during the entire event all of the cardiac data from the event was used in this analysis. This method was considered preferable to substituting scores from other points in time.

For the 12-event films the difference scores on the three events described above were analyzed in a 2 (films) x 3 (events) x 12 (half-second intervals) fixed model analysis of variance with repeated measures on the last two factors. The least squares approach using the Multivariance (Finn, 1972) program was employed. A significant effect of events resulted, F (1,24) = 5.93, $p < .05$, and post hoc comparisons revealed that a significant cardiac deceleration occurred in the first action role reversal as compared to the last standard event. Apparently the action role reversals were detected in both films since there was no film x event interaction ($p > .05$). The lack of a film x event interaction indicates that the null hypothesis for the second question, namely that the anomalous reversal is not perceived beyond the effects of the action role reversal, cannot be rejected. Across the 12 half-second intervals significant linear and cubic trend components were found, F linear (1,24) = 10.57, $p < .005$, and F cubic (1,24) = 14.96, $p < .001$. The typical pattern of response to these filmed events appears in Figures 4 and 5.

Insert Figures 4 & 5 about here

Discussion

The major hypothesis of this study, namely that infants can perceive action role reversals regardless of changes in the direction of action, has been confirmed. Infants showed clear recovery of visual fixation and

a cardiac deceleration to the reversal events in the man-chair film. The results for the man-man film were mixed; according to the 16-event visual fixation data and the 12-event heart rate data the reversals were detected. However, the reversals in the 12-event visual fixation data fell short of significance.

The lack of concordance between the 12-event visual fixation and heart rate data on the man-man film is difficult to explain. It would be tempting to conclude that heart rate change is a more sensitive measure than visual fixation if this study had not also included the 16-event films. In that data, visual fixation shows clear recovery while the heart rate data were too full of artifact to analyze. It may be that obtaining evidence of habituation and recovery using visual fixation is to some extent incompatible with obtaining unequivocal data using cardiac change. While the movement associated with turning away from the film and fidgeting is related to habituation of the visual fixation response, this same movement may not permit reliable computation of the heart rate data (at least without telemetry attachments). Researchers may need to choose between these measures cautiously.

Despite the lack of significance on the 12-event man-man visual fixation data, it appears that infants detected the action role reversals in both films. This finding replicates and extends the findings of prior studies since the direction of action changed throughout the film. Infants had to abstract the basic role information across continuing changes in the position of the actors and the direction of action in the standard events. None of the previous studies with filmed events (nor certainly the great majority of existing studies using the habituation paradigm) have presented infants with events as complex as these. The evidence from this study, in

combination with prior studies, strongly suggests that infants are capable of distinguishing changes in the initiator and recipient of action in perceptual events.

What are the implications of this finding for language development? None of the subjects in this study produced any two-word utterances during the testing. Over an average of 41.28 vocalizations during the half hour experimental session, of which only an average of 12.24 were intelligible utterances, no child had a mean length of utterance (MLU) longer than 1.00. (Brown's (1973) rules were used to compute MLU). The receptive vocabulary measure indicated that out of the 15 common nouns and 4 verbs assessed, the average number known was 8.26 and 1.07 respectively. The fact that action role reversals were perceived by infants with this relatively low level of language development may indicate that the cognitive categories of action initiation and action recipience are developed prior to the linguistic encoding of these concepts in two-word utterances.

It is still possible to argue, as Schlesinger (1974) does, that the child's experience with the language causes him to form the categories of agent and recipient. By noting the consistent way they are encoded linguistically by others, the child may acquire the concepts and the rules for translating them into speech. However, if language does facilitate the perception of these role relations it may be more in the way Bruner (1975) described. The infant's mother or caregiver may use language to parse the structure of events for her child, thereby highlighting the separate aspects of agent, action and object.

On the other hand, perhaps specifically linguistic knowledge does contribute to the child's circumscribing of the agent class to include only animate objects. There are two hypotheses about when the restrictions on the agentive class develop. The first is that infants abstract information about which things can act and which can not prior to the production of two-word utterances. The second alternative is stated nicely by Bowerman (1974): "...a child might initially form an overextended agent concept in which animate agents and instruments like knives (and perhaps inanimate 'agents') are regarded as equivalent, and gradually, through observation of the way these are treated linguistically, he would differentiate agent and instrument into two separate concepts" (p. 202). The data from the present study indicate that the animacy feature may not be a salient aspect of events until later in development. Whether this differentiation is then based purely on the perception of object relations in events or whether linguistic information is also used, is an empirical question. At any rate, the criteria by which adults and school-age children define agency (e.g., animate only) may not be a criterion for the prelinguistic child.

The third reason this study was conducted was to see if the promising findings of Gilmore, et al., (1974) on the dependent variable of cardiac deceleration could be replicated. Apparently, the cardiac response is sensitive to within and between event change as those authors concluded. Within the event (see Figures 4 and 5) there is a characteristic response pattern of an initial plateau, followed by a dip, and then an upturn. This pattern seems to correspond to the structure of these events. When the

event appears on the screen, the actors first face each other without movement. This portion may correspond to the initial plateau. The maximal dip in these events would occur then at the point of contact and interaction between the actors. The between event sensitivity is also mirrored in these Figures which show large decelerations to the first reversal.

In sum, the evidence which suggests that minimally verbal infants can perceive the initiator and recipient of an action is increasing. In this study, infants abstracted action role information from a constantly changing standard event and showed dishabituation, or orienting, to the action role reversals. Certainly this result will need to be replicated with diverse actions and actors. But the fact that several studies seem to obtain similar results (Golinkoff, 1975; McHale, 1973; Gilmore, et al., 1974) suggests that one set of action role categories (agent and recipient) may have psychological reality for infants in their perception of events. On the other hand, there is little evidence that infants consider the category of agent to include only animate objects. Their responses to anomalous and plausible reversals did not differ significantly.

These findings provide only indirect evidence for the presence of such categories in early speech. Future research should focus on the relationship between children's perception of case role categories as portrayed here and their comprehension and production of language.

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Footnotes

* Portions of this paper were presented at the Biannual Society for Research in Child Development Meeting, April, 1975. The data for this study were collected while the senior author was a post-doctoral fellow at the Learning Research and Development Center, University of Pittsburgh. The Center's support as well as the support of the Pittsburgh Child Guidance Center (affiliation of the second author) are greatfully acknowledged. We would also like to thank the many parents and children who participated in our study and Mary Gallagher, Diane Hargett, and Norman Steitler for their invaluable assistance in data collection and coding. William Treat, our research coordinator, deserves special thanks as does Dr. Jay Price for his assistance in data analysis. Requests for reprints should be sent to the first author at the Department of Educational Foundations, University of Delaware, Newark, Delaware 19711.

Figure Captions

Figure 1. The composition of the films.

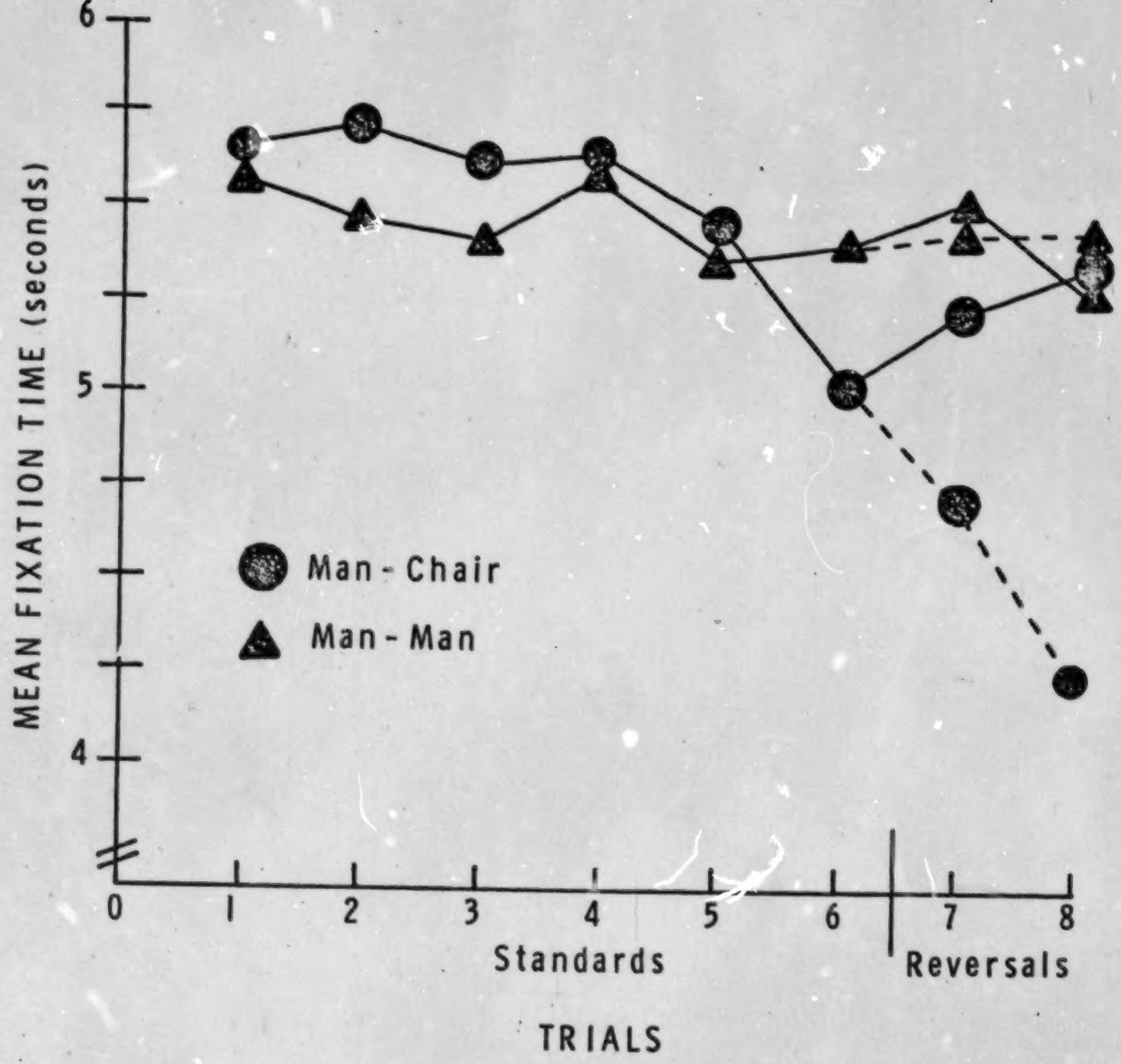
Figure 2. Mean visual fixation time to the standards and action role reversals in the 12-event man-chair (n=15) and man-man (n=19) films.

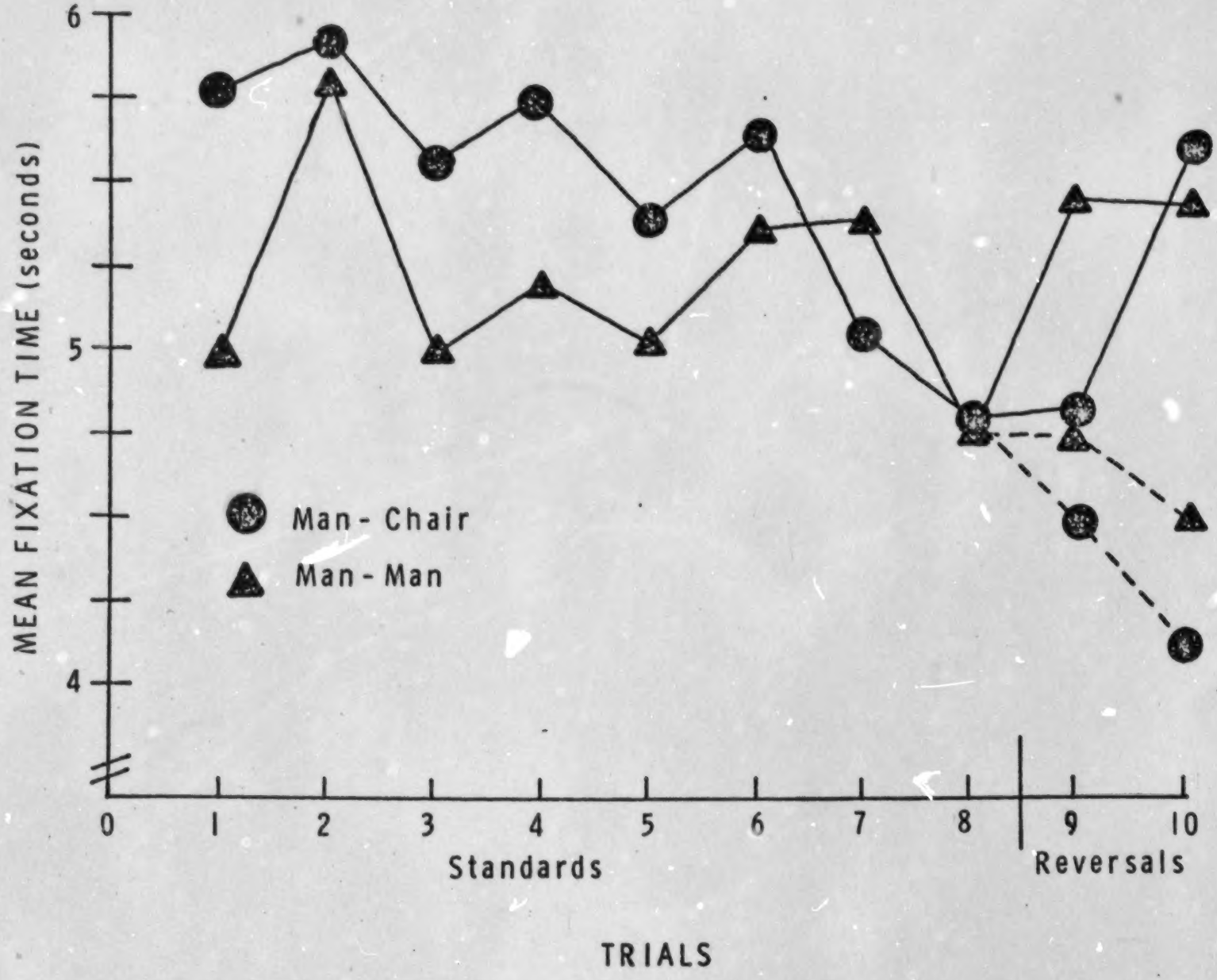
Figure 3. Mean visual fixation time to the standards and action role reversals in the 16-event man-chair (n=12) and man-man (n=6) films.

Figure 4. Mean cardiac response to the first and last standards and the first action role reversal in the 12-event man-chair film (n=11).

Figure 5. Mean cardiac response to the first and last standards and the first action role reversal in the 12-event man-man film (n=15).

EVENT TYPE	TRIALS	DESCRIPTION
STANDARD	1. A -->B	Actor A pushes Actor B from the left to the right (or right to left).
	2. B <-- A	
	3. A -->B	
	4. B <-- A	
	5. A -->B	
	6. B <-- A	
ACTION ROLE REVERSAL	1. B -->A	Actor B pushes Actor A from the left to the right (or right to left).
	2. A <-- B	
	3. B -->A	
	4. A <-- B	
	5. B -->A	
	6. A <-- B	


MEAN FIXATION TIME (seconds)
6
5
4
Man - Chair
Man - Man
0
1
2
3
4
5
6
7
8
Standards
Reversals
TRIALS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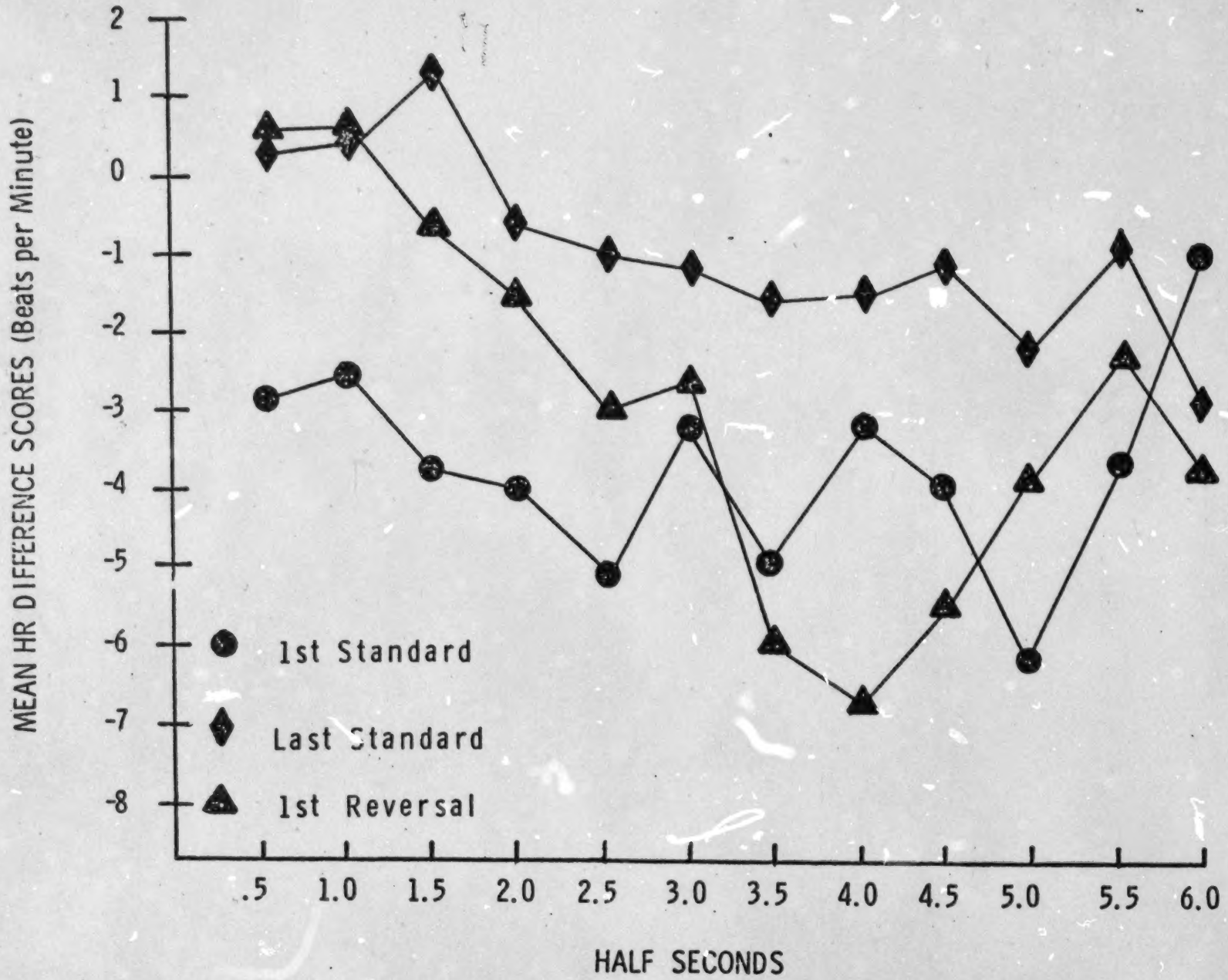
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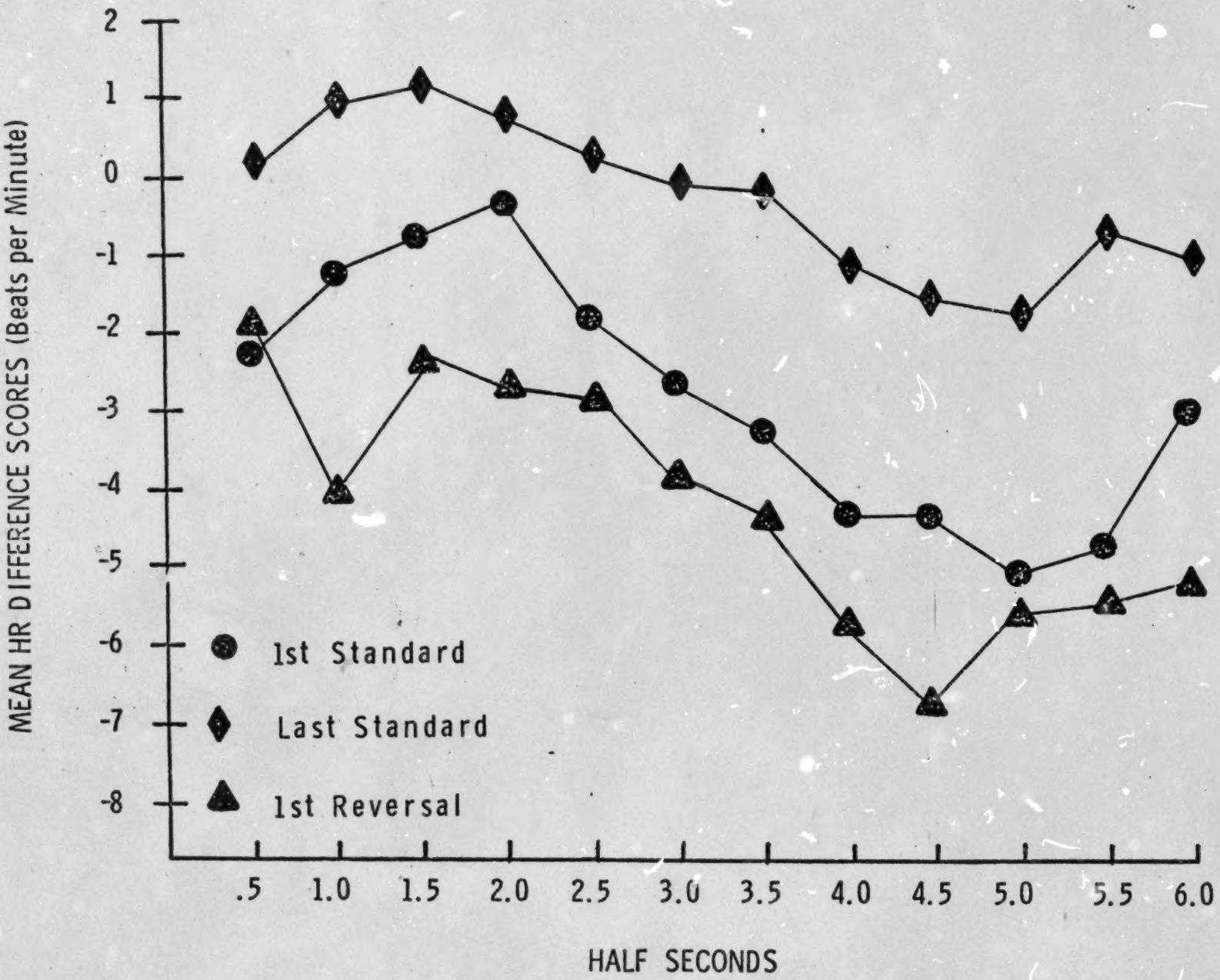
6.0
HALF SECONDS


MEAN HR DIFFERENCE SCORES (Beats per Minute)
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
1st Standard
Last Standard
1st Reversal
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
HALF SECONDS